

# SRI CAT NEWSLETTER

Synchrotron Radiation Instrumentation Collaborative Access Team Newsletter

Vol. 1, No. 3

January, 1995

## *From the desk of the Executive Director:*

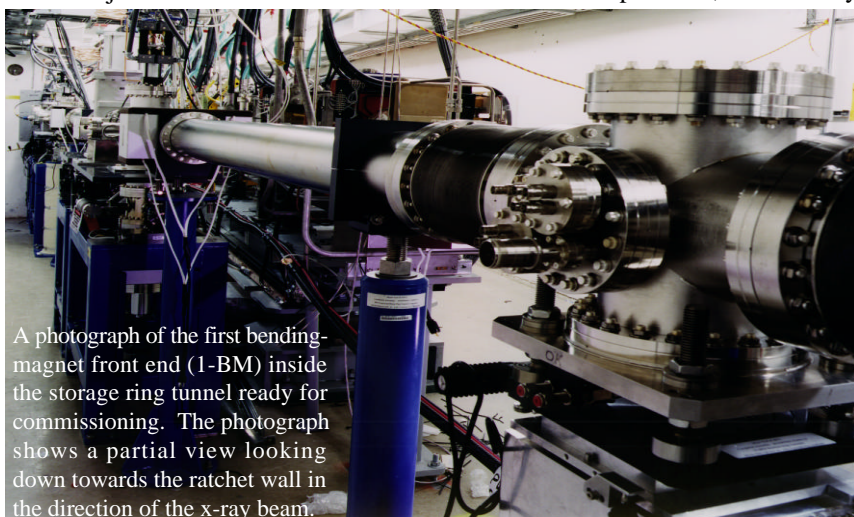
Let me wish you all a belated happy new year. The year 1995 is significant from many points of view. This year, 1995, is the 100th anniversary of the discovery of x-rays (in fact, the APS will be commemorating this event later on in the fall), but it will be the year that x-rays will be "discovered" in copious quantities at the APS. Be patient, only a few more months! Along these lines, I tried to recollect when I started "waiting" for beam from the APS. After rummaging through an old folder labeled "New Rings" (I don't recall if there was a name picked out yet for these new third-generation sources), I found the answer. My first involvement with a new third-generation of storage rings began while I was still at CHESS. At that time, Cornell was an active player as a potential candidate for design and construction of a new dedicated, low-emittance source. Several members of the CESR and CHESS staff, such as myself, were involved in attending meetings, preparing a prospectus for a dedicated synchrotron radiation facility, and contributing to the scientific justification of such a source.

(Cornell later decided to drop out of the running.) That was in 1984, so I guess I can wait a few more months. We certainly won't be idle during those months. Besides installation of beamline hardware, members of the SRI CAT can look forward to participating in several important reviews including the Safety Analysis Document (SAD) Review for the Experiment Beamlines and a Commissioning Readiness Review. In addition, submission of the Sector 1 Final Design Report (FDR) is scheduled for early February, and a host of procedures need to be developed before beam is extracted from the storage ring.

This issue has articles on high-heat-load mirrors and monochromators, an area of very active research by many members of the SRI CAT. Although much work still needs to be done in this area, some very successful and promising tests were recently performed by SRI CAT members, in collaboration with ESRF and SPring-8, on cryogenically cooled silicon crystals. In November, we were fortunate to get several days of beam time on a focused wiggler beamline (BL3) at the ESRF to test an integrally cooled, thin silicon crystal designed in collaboration with Gordon Knapp (MSD). To summarize the results of this experiment, no thermally

induced broadening of a 2-arc-second rocking curve was observed with absorbed powers and power densities in excess of 150 watts and 80 watts/mm<sup>2</sup>, respectively! (The normal incidence power density in this experiment was over 400 watts/mm<sup>2</sup> - considerably higher than that expected from the 2.5-m undulator A operating at 100 mA.) This result bodes well for the successful operation of cryogenically cooled silicon monochromators as first optical components on undulator lines at the APS.

Between this newsletter and the last several noteworthy events have occurred. An SRI CAT meeting for both Developers and Scientific Members was held here at ANL on November 21. Thanks to all who participated, in particular to those non-ANL members who had to travel to Argonne. (More details on this meeting can be found in the newsletter.) Installation has begun on the 1-BM first optics enclosure (FOE). Technical discussions were held with the vendor for the design of the 1-BM monochromator. Last, but by no means the least, we hosted representatives of the x-ray community from Australia who were interested in potential participation in the SRI CAT. When you throw in the fact that the Thanksgiving, Christmas, and New Years holidays fell into this period, you realize it was a busy time. *D.M. Mills ¶*



A photograph of the first bending-magnet front end (1-BM) inside the storage ring tunnel ready for commissioning. The photograph shows a partial view looking down towards the ratchet wall in the direction of the x-ray beam.

## Table of Contents

From the Desk	1
Preliminary Performance Measurements of the Kohzu Double-Crystal Monochromator	2
Advantages of Using a Mirror as the First Optical Component for APS Undulator Beamlines	5
SRI CAT Meeting Synopsis	7
Calendar	8
People	8
Publications	8

## Double-Crystal Monochromator

The SRI CAT 1-ID double-crystal monochromator (DCM) was delivered to the APS in January 1993. It was designed, fabricated, and assembled by the Kohzu-Seiki Company in Tokyo, Japan. The original Statement of Work (SOW), procurement document listing the required performance specifications, can be found in ANL Technical Bulletin ANL/APS/TB-4. A summary of the critical performance specifications are as follows:

the DCM must operate at fixed-exit eight

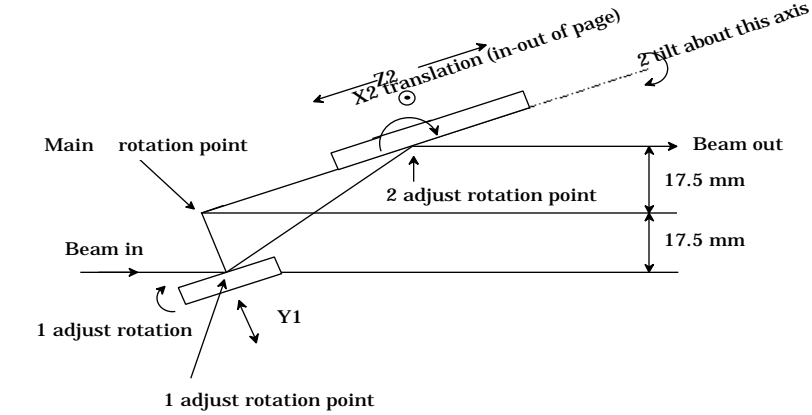
there must be a 35-mm vertical offset between incoming and outgoing beams the DCM must be tunable over the (4-0 keV) classical energy range with i(111) crystals

the angular resolution of the first crystal must be 5  $\mu$ rad or better

the DCM must be high vacuum compatible ( $10^{-7}$  to  $10^{-8}$  Torr range)

the design must be independent of the details of the crystal geometry and of the cooling scheme.

A few changes and additions to the original SOW were made after the contract was awarded. The most important of these are: (1) the resolution of the Z2 range was increased from 1 arc minute to 5 arc seconds, and (2) an in-vacuum motorized motion, Z2, was added. Figure 1 shows all the motions for the DCM in the final design. Note that because the two crystals are not mechan-



Entire tank also moves horizontally (X), and vertically (Y).

Figure 1. Sketch showing all the monochromator motions. See Table I for a description of the motions.

cally linked (as in the “boomerang” design), the DCM can be operated in a number of ways: (a) a “channel-cut” mode in which the two crystals stay fixed relative to one another during an energy scan, (b) a fixed exit mode in which only Y1 moves during an energy scan, and (c) a fixed-exit mode in which both Y1 and Z2 move during an energy scan. Mode (a) is not a fixed-exit mode, and thus the beam moves vertically during a change in energy. Mode (b) is a fixed-exit mode, but the beam walks across the face of the second crystal. Thus, long crystals may be needed. Mode (c) is a fixed-exit mode in which the beam stays centered on the faces of both crystals.

Table I shows the as-built range and

resolution of the translations/rotations of the DCM. Since delivery, a lot of effort has been put into interfacing and integrating the EPICS-VME software and hardware required to drive the DCM (thanks to Tim Mooney and Dave Reid). Currently, the DCM (with all three possible operation modes) and all the monochromator accessories, such as the liquid gallium pump, vacuum gauges, encoders, and thermocouples are completely interfaced to a Sun workstation. Tests have mainly focused on the functionality of the piezo-electric (PZT) driven motions, the straightness of the Y1 and Z2 translations, and the verification of the various motion resolutions. All these tests were performed with the DCM open (at

Table I

Motion	Function/Drive	SOW requirement	As-built
X range	Translates entire tank	+/- 25 mm	> +/- 25 mm
X resolution	horizontally/ stepper motor	0.1 mm	0.5 m/step $\mu$
Y range	Translates entire tank	+/- 25 mm	> +/- 25 mm
Y resolution	vertically/ stepper motor	0.1 mm	0.11 m/step $\mu$
range	Overall rotation/	-5 to +30 °	-5 to +30 °
resolution	AC Servo motor	1 arc second	0.1 arc sec/step
1adj fine range	Fine adjust for 1st crystal/PZT	120 arc seconds	150 arc seconds
Y1 range	Translates 1st crystal relative to rotation axis. Used for fixed	10 mm	17 mm
Y1 resolution	offset/In-vacuum stepper motor	0.1 mm	0.1 m/step $\mu$
Y1 yaw		1 over 6 arc sec over mm	1-2/10 arc sec/mm
2 range	Tilt adjust for the second	+/- 5 °	+/- 10 °
2 resolution	crystal/In-vacuum stepper motor	5 arc seconds	1.01 arc sec/step
X2 range	Translates 2nd crystal laterally/	25 mm	25 mm
X2 resolution	In-vacuum stepper motor	0.1 mm	0.1 m/step $\mu$
Z2 range	Translates 2nd crystal along	+/- 60 mm	+/- 60 mm
Z2 resolution	the beam direction/In-vacuum	0.1 mm	1 m/step $\mu$
Z2 yaw	stepper motor	10/120 arc sec/mm	< 4/120 arc sec/mm
2adj coarse range	Coarse adjust for 2nd crystal/	+/- 1 °	> +/- 1 °
2adj coarse res.	In-vacuum stepper motor	1 arc minute	0.026 arc sec/step
2adj fine range	Fine adjust for 2nd crystal/PZT	120 arc seconds	150 arc seconds

sociated with making autocollimator measurements in vacuum prevented in-vacuum measurements. The measurements were also limited by the overall stability of the autocollimator. The autocollimator was usually only stable to about 0.1-0.5 arc seconds, depending on the exact setup, and it has a slow overall drift, which varies from 1 to 5 arc seconds per half hour.

The PZT-driven stages (1adj and 2adj) on the first and second crystals are critical to the proper functioning of the DCM. The main function of the PZT adjustments is to correct for the inevitable misalignments and thermal drifts between the two crystals. In this design, the PZTs have to push a considerable

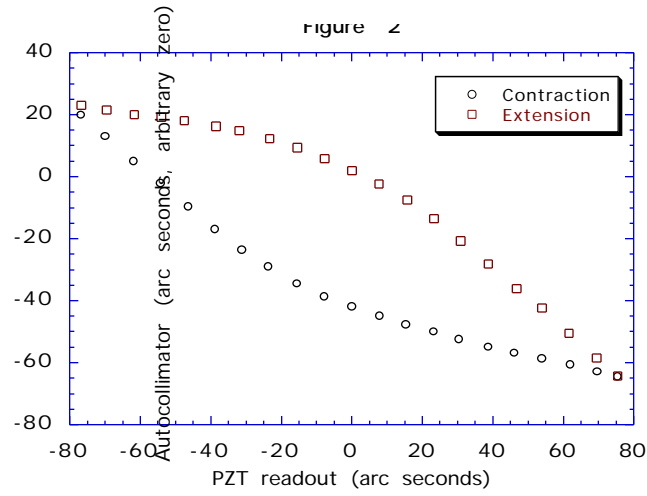


Figure 2. Rotation of the 2 PZT adjust stage in the original design, in which the stage is supported by six wheels and rollers. The range of rotation measured (by autocollimator) is about half of what it should be ( $\sim 155$  arc seconds). These data are for  $\theta = 0^\circ$  with no load. The two sets of data are for PZT extension and contraction. Clearly, the stage is sticking.

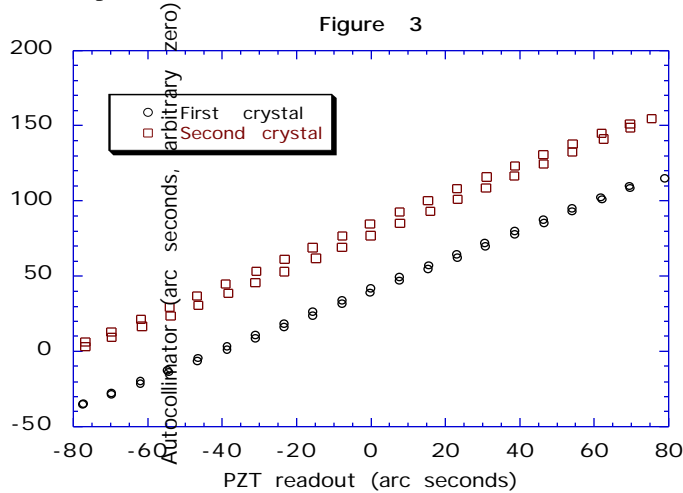


Figure 3. Rotation of the 1 and 2 PZT adjust stages after the Kohzu refit. The new stage is supported by conventional ball bearings. These data were taken (with an autocollimator) at  $\theta = 30^\circ$ , where the maximum effective weight is pushing against the PZTs. Dummy 10 kg and 5 kg weights were placed on the first and second crystals stages, respectively, to simulate the weight of the actual crystals and mounts.

amount of mass in both the first and second crystal  $\theta$ -adjust stages. The maximum extension of the PZTs is about 75 microns. The lever arm from each PZT pushing point to the center of the rotation is 100 mm. Thus, the maximum expected rotation due to the PZT motion is about 155 arc seconds. A major concern is whether or not the PZT motions are smooth and reproducible. When the DCM was first delivered in January 1993, each PZT-adjust rotation stage was supported by six rollers and wheels. Figure 2 shows the 2 fine adjust rotation due to the PZT extension as measured by an autocollimator. From the large hysteresis and the measured range of motion (about half of

what is expected), it is clear that the PZT stage was “sticking”. Kohzu personnel came to ANL and changed the PZT stages. The new PZT stages have conventional ball bearings, and in Figure 3 we show the measured rotations (back and forth) of the new first and second crystal PZT driven stages. These figures show that the range of the PZT motions is close to the expected values and that the amount of hysteresis in the system is considerably reduced. Note that the measurements were made with steps covering several arc seconds. In these measurements, the resolution was limited by the autocollimator stability. The motion of the PZT in the sub-arc-second range can be seen in Figure 4, which is a (+,-)rocking curve of a Si(111) x Si(111), crystal taken with Mo K radiation. The measured width of

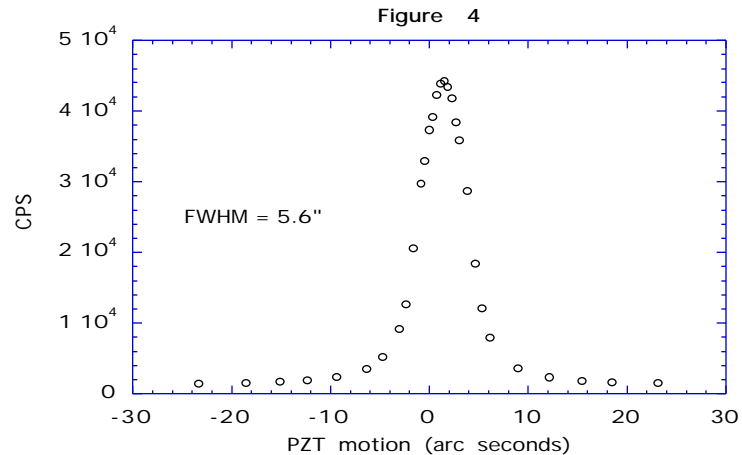


Figure 4. A MoK Si(111) x Si(111) double-crystal rocking curve measured by rocking the second crystal via the PZT. The measured width is slightly broader than the theoretical width of 4.2 arc seconds, likely due to mounting strains in the crystal. Step sizes varied from 0.35 to 5 arc seconds.

theoretical width, probably due to strains in the crystals we used. The step sizes taken varied from 0.35 to 5 arc seconds.

In order to keep the fixed-exit beam eight fixed during an energy scan, the first crystal must be translated (Y1). If one is interested in keeping the beam centered on the second crystal, the second crystal must also move (Z2). When the monochromator is operated in this manner, the yaw of the Y1 and Z2 translation stages is critical if one expects to stay on the Bragg peak during an energy scan. (Here, yaw is defined as the rotation that changes the Bragg angle of the crystals.) If the yaw of these stages is large (compared to the Darwin

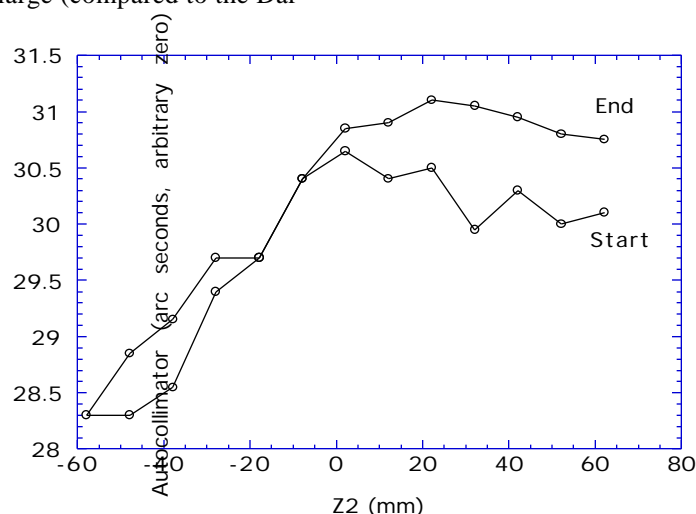


Figure 6. Yaw of the Z2 translation stage as measured by an autocollimator. A dummy 5 kg load at  $\theta = 0^\circ$  was used.

widths of the reflection), the reflection will be lost during an energy scan. Figure 5 shows the measured yaw of the Y1 stage with a dummy 10 kg load at  $\theta = 30^\circ$ . The measured yaw of the Y1 stage is about 1-2 arc seconds for 0 mm of travel. Note that the actual motion required for a fixed offset is less than 3 mm between 4 and 20 keV for a Si(111) crystal. Figure 6 shows the measured yaw of the Z2 translation stage with a dummy 5 kg load at  $\theta = 0^\circ$ . In this case, the measured yaw is about 3 arc seconds for 120 mm of travel. The data suggest that it should be possible to scan in energy while staying within the Bragg peak. Of course, a small PZT adjustment (manual or in a feedback loop) may be necessary to stay on the peak exactly.

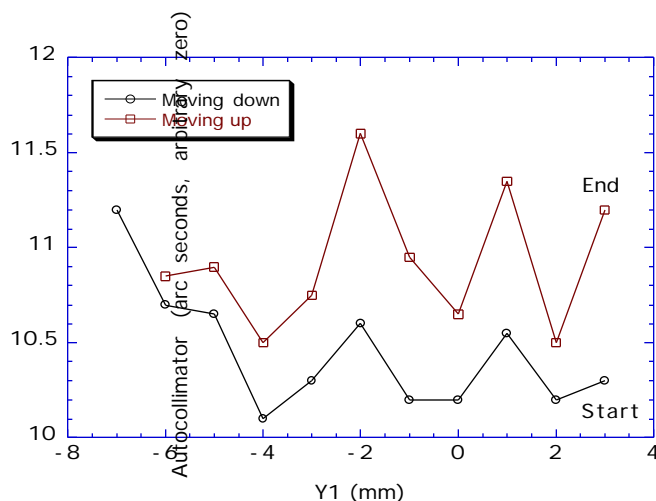


Figure 5. Yaw of the Y1 stage as measured by an autocollimator. Measurements done with a dummy 10 kg load at  $\theta = 30^\circ$ . The overall displacement of the data between the up motion and the down motion is probably due to the slow drift in the autocollimator.

Another aspect of the DCM that is of interest to some users is the angular error of the main rotation stage. This error is due to fabrication imperfections in the gear-drive mechanism. In Figure 7, we show the measured angular error of the Kohzu DCM for moving from  $0^\circ$  and  $30^\circ$ . The total error is about 10 arc seconds.

Finally, because the monochromator has a large number of in-vacuum components, the time it takes for the chamber to pump down is of concern. Shortly after the DCM was delivered to the APS, a vacuum pump-down test was performed. With a 400 l/s turbomolecular pump and a 400 l/s ion pump, the system took about 24 hours to go from atmosphere to  $10^{-6}$  torr and another 24 hours to reach  $10^{-7}$  torr.

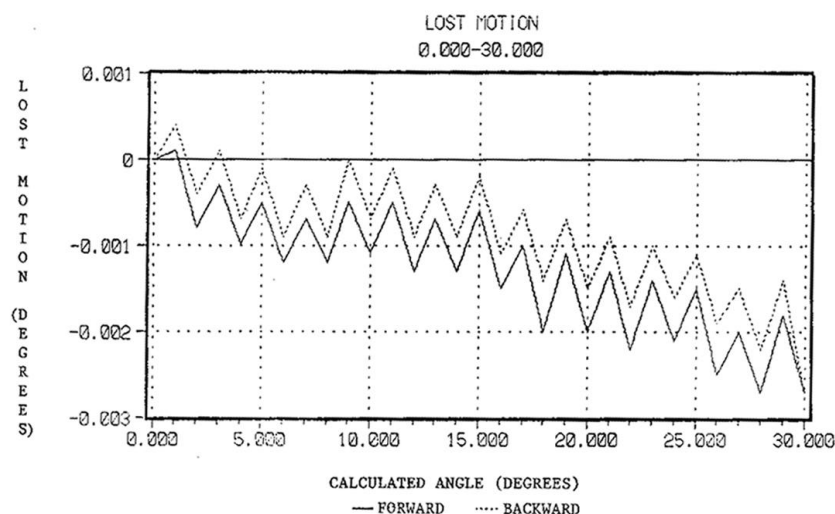


Figure 7. Angular error of the main rotation stage, measured by autocollimator.

for other tests and modifications (including the Kohzu retrofit of the PZT stages). Thereafter it remained open for about 10 months. The next vacuum pump-down took about 48 hours to go from atmosphere to  $10^{-6}$  torr. All vacuum tests were done at room temperature without any baking, which is not recommended due to the high vapor pressures of the in-vacuum lubricants at elevated temperatures ( $\sim 100^\circ\text{C}$ ).

One possible option for dealing with the high power and size densities of the APS undulator A on the 1-ID line is to use inclined crystals with the liquid-gallium pump. The first commercial liquid-gallium pump, made by Qmax Corporation, has been checked out and is

Currently, we plan to use a  $78^\circ$  inclined Si(111) crystal for the 8-20 keV range and an  $85^\circ$  inclined Si(111) crystal for the 4-9 keV range. The inclination angles and energy ranges are chosen such that the surface power density on the crystal does not exceed  $5\text{ W/mm}^2$  and the crystals are less than 250 mm long. Experiments at CHESS and NSLS and computer simulations have shown that thermal distortions are minimal for surface power densities below about  $5\text{ W/mm}^2$ . The lengths of the second crystals are chosen so that no Z2 translations are necessary for the energy range. Thus, the beam will walk across the face of the second crystal. Prototypes of both crystals have been made and are being tested in-house. However,

in the inclined crystal, the prototypes, which were epoxied together in-house, will most likely not be optimum for flux or brilliance. We are currently investigating possible bonding options to minimize the bonding-induced strains. Possibilities include frit-glass bonding, gold-based solder, and direct silicon-silicon bonding. The cooling geometry will most likely utilize either core-drilled holes or slotted cooling channels.

In summary, the limited tests we have performed on the Kohzu DCM shows that it satisfies the SOW specifications. However, we note that the true test of the DCM can only be conducted on the experimental floor. Current plans are to install the DCM on the beamline in early 1995. *Wah Keat Lee*

## Advantages of Using a Mirror as the First Optical Component for APS Undulator Beamlines

X-ray mirrors are widely used in synchrotron x-ray beamlines for a broad range of applications, such as beam separation, focusing, and power filtering. In the SRI-CAT Sector 2 insertion-device beamlines,<sup>1,2</sup> an x-ray mirror with three stripes of different coating materials is used to achieve the following four objectives:

- a substantial reduction in the peak radiation heat flux and total power on the downstream monochromator so that a water-cooled, conventional symmetric double-crystal monochromator (DCM) can be used;
- a significant reduction in the radiation shielding required, such that undulator radiation in the 0.5-32 keV spectral range can be delivered to the experimental stations with shielding requirements similar to those for monochromatic beams;
- suppression of unwanted higher-order undulator harmonics; and
- separation of the undulator radiation from the bremsstrahlung, such that a DCM can be used as a quasi-channel-cut monochromator with negligible displacement of the diffracted beam from the incident beam.

The SRI-CAT Sector 2 insertion-device beamline consists of three branch

lines that share the same straight section of the storage ring, front end, first optical enclosure, and first horizontal deflection mirror (M1). Mirror M1 is located about 31 m from the undulator. The mirror is 120 cm (L) x 9 cm (W) x 12 cm (D); the substrate material is Si, and it is internally cooled. It has a plane figure with three parallel reflecting surfaces, one being the polished Si surface itself, while the other two are stripes coated with Rh and Pt. The mirror has been designed and is expected to be delivered in early 1995. The anticipated rms (root mean square) slope error of the mirror under actual thermal loading conditions is better than 2 and 30  $\mu\text{rad}$  in the tangential and sagittal directions, respectively. The anticipated rms surface roughness is 3 Å. The vacuum and mechanical systems for this mirror have been designed and are currently being manufactured.

At a grazing incidence angle of  $0.15^\circ$ , the high energy cut-offs of the three reflecting surfaces are about 12 keV for Si, 24 keV for Rh, and 32 keV for Pt. Therefore, suppression of unwanted higher-order harmonics of the undulator radiation over the 6-32 keV undulator spectral range can be obtained by selecting an appropriate surface.

A fixed mask is used to reduce the power of 3.8 kW from undulator A at a closed gap of 11.5 cm to 1.4 kW, which is the maximum total power incident on the mirror. The peak heat flux incident on the mirror surface is  $0.36\text{ W/mm}^2$ . Because this incidence angle is much smaller than that for a typical crystal monochromator, the heat flux on the mirror surface is substantially smaller than that on the first crystal surface when it is used as the first optical component. Consequently, the thermal loading problem is easier to solve for a mirror than for a crystal. In addition, a broad range of materials with favorable thermal and mechanical properties may be used for the mirror because crystallinity of the substrate is not required.

The peak power density of the raw undulator A spectrum as a function of the undulator gap is shown in Fig. 1. Also shown in the figure are the power densities of the undulator spectrum integrated over the three energy bands indicated. It is clear from the figure that a substantial reduction in the peak power density can be obtained by filtering out the high energy part of the raw undulator spectrum. Because the reflectivity of a mirror is small for x-rays with energies greater than the cut-



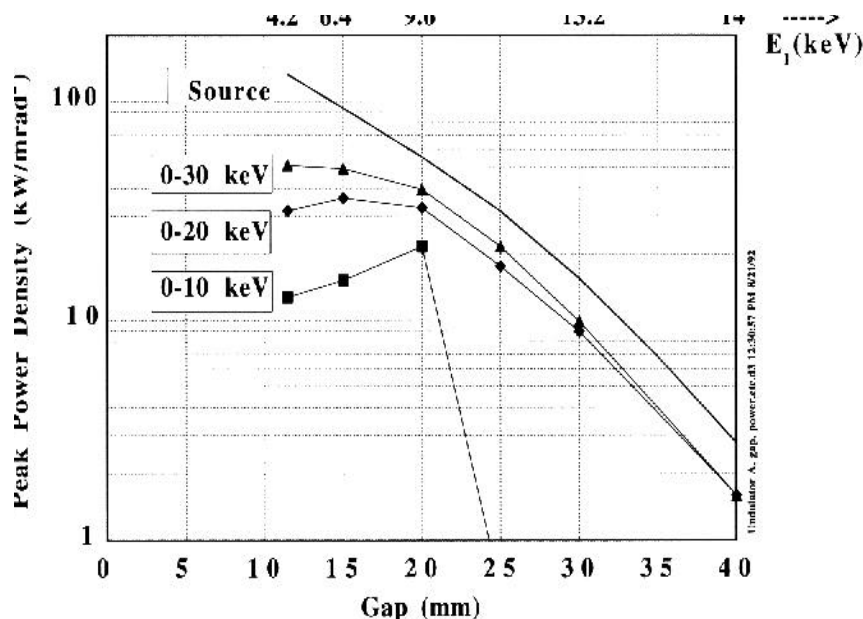


Fig. 1 Calculated peak power densities for the entire undulator A spectrum as a function of undulator gap and for the three energy bands indicated. The first harmonic energy corresponding to the undulator gap is shown at the top.

ff energy at a given incidence angle, ie power densities calculated for the iree energy bands in Figure 1 can be pproximated by the power densities of ie undulator A spectrum as reflected y the three mirror surfaces. Note that power density reduction of about 10 obtained at a undulator gap of 11.5 m when using a mirror with a cut-off energy of 10 keV. In addition to the duction in power density, the total ower reflected by the mirror is also

reduced.

Because of the heat flux and power reduction in the reflected beam, the thermal loading problem for a DCM is much easier to handle. Reduction of the radiation shielding required also allows us to place the DCM far away from the undulator. For a DCM located 65 meters from the undulator source, which is the case for one of our branch lines, the calculated heat flux incident on the first crystal of a Si DCM tuned

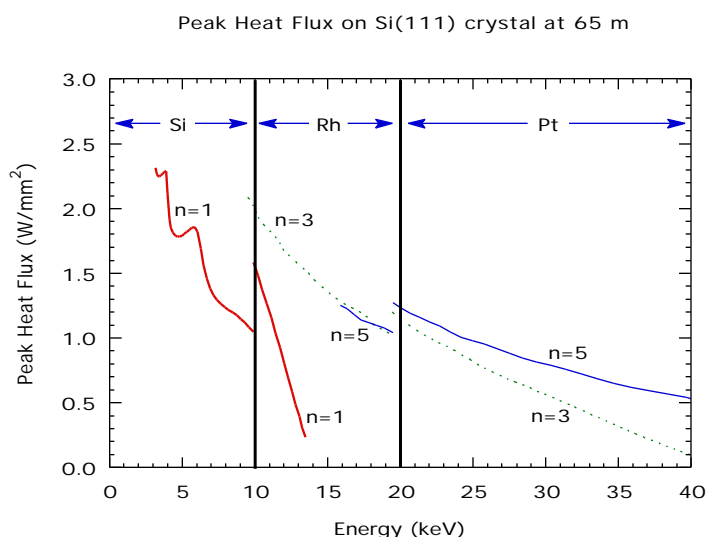


Fig. 2 Peak heat flux on the surface of a Si(111) crystal located at 65 m from undulator A. The Si crystal is tuned to diffract the energy labeled along the axis, which can be obtained from the first, third, and fifth harmonics of the undulator. It is also assumed that the Si mirror will be used to cover an x-ray energy range of 0-10 keV, the Rh and Pt mirrors to cover the 10-20 keV and 20-40 keV energy ranges, respectively. The grazing angle of incidence on the mirror is  $0.15^\circ$ .

for (111) Bragg reflection is shown in Fig. 2. When the appropriate mirror coating is used, the maximum heat flux on the first crystal is less than  $2 \text{ W/mm}^2$ . For this heat flux, it will be possible to use a simple cooling geometry for the first crystal to obtain a thermally-induced slope error of a few microradians.

Use of the mirror also allows us to deliver the undulator beam to the experimental stations with radiation shielding requirements similar to those for a monochromatic beamline. A detailed study has been published elsewhere<sup>3</sup>, and a brief summary of the rationales is given here. In the first optical enclosure, the bremsstrahlung is separated from the reflected synchrotron beam by the mirror M1 and is subsequently blocked by a tungsten stop. Downstream of the first optical enclosure, the radiation shielding for the beamline transport is determined mainly by the high energy synchrotron radiation. Because of the low reflectivity of the mirror for x-rays with energies greater than 32 keV, the amount of shielding required for the reflected wide-band beam is similar to that for a beam monochromated by a double-crystal Si monochromator alone.

Horizontal deflection of the synchrotron beam by the M1 mirror is used in order to preserve the high brilliance of the undulator beam. The brilliance is preserved due to two reasons. First, the reduction in the beam brilliance for a given mirror slope error is less than it would be if the beam were to be deflected vertically, because the FWHM beam divergence of undulator A at the APS in the horizontal direction is about 2.5 times that in the vertical direction. In addition, because the increase in rms divergence of the reflected beam in the horizontal direction is about 4 times the rms tangential slope error of the mirror and approximately equal to  $\sin \theta$  in the vertical direction, where  $\theta$  is the mirror rms sagittal slope error and  $\theta$  is the incidence angle, we also expect the beam coherence in the vertical direction to be preserved. Second, the gravitational force is parallel to the mirror surface, thus gravity-induced sagging of the mirror will have negligible effect on

tial direction.

In conclusion, significant advantages can result from the use of a mirror as the first optical component in undulator beamlines, such as the mirror we will use in Sector 2-ID. These advantages include power filtering, reduction of the necessary radiation shielding, and suppression of high-order harmonics. Because of power filtering, the design of downstream optical components such as monochromators is greatly simplified. The reduction in radiation shielding lessens not only the beamline con-

effort required. Suppression of high-order undulator harmonics is particularly important when the critical energy of the undulator radiation is greater than the first-harmonic energy.

The authors would like to acknowledge many useful discussions in the development of this beamline design with B. Stephenson, G. Knapp, S. Davey, Z. Cai, P. DenHartog, D. R. Haeffner, P. K. Job, T. Rauchas, E. Alp, N. Ipe, and T. Sanchez.

References:

1) W. Yun, A. Khounsary, B. Lai, and

Optical Component for an Undulator Beamline at the APS," ANL/APS/TB-2, 1992.

2) Preliminary Design Report (PDR) of SRI CAT Sector 2 Beamlines.

3) W. Yun, B. Lai, K. Randall, S. Davey, D. R. Haeffner, P. K. Job, and D. Shu, "Radiation Shielding of Insertion-Device Beamlines Using a Mirror as the First Optical Element," to be published as an ANL/APS technical bulletin. W. Yun, A. Khounsary, B. Lai, K. Randall, I. McNulty, E. Gluskin, D. Shu ¶

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## SRI CAT November Meeting

A major meeting was held on November 21, 1994 for the developers and scientific members of SRI CAT. Its objectives were to inform all members about the beamline construction and commissioning schedules and to present perspectives on the first experiments to be conducted by SRI CAT.

Dr. D. Mills, SRI CAT Executive Director, opened the floor. E. Gluskin, SRI CAT Program Director, presented a brief update on the accelerator and insertion device installation schedule. The beamline construction and commissioning schedules for Sectors 1, 2, and 3 were presented by Sector Coordinators, G. Srajer, W. Yun, and E. Alp. Highest priority was given to construction and commissioning of Sector 1 to make immediate use of x-ray beams for beam diagnostics and high-heat-load optics testing. The initial commissioning dates for the Sector 1 bending-magnet and insertion-device beamlines are 3/13/95 and 5/4/95, respectively. The earliest commissioning dates for Sector 2 and Sector 3 beamlines are late summer of 1995. Many scientific members were very pleased about the speed and quality of the beamline construction.

In the afternoon session, several scientific members presented their perspectives on the first experiments they want to conduct once the beamlines become operational.

On the subject of x-ray microscopy, Dr. W. Haddad of Lawrence Livermore

National Laboratory presented recent work on high-resolution, three-dimensional-tomography-based use of a soft x-ray scanning microscope. He demonstrated that a three-dimensional spatial resolution of better than 0.1  $\mu\text{m}$  can be obtained with a test sample. The advantages of using high brilliance hard x-rays for material biological research and some applications were also discussed.

Prof. C. Jacobsen of the State University of New York at Stony Brook discussed some important biological applications of x-ray microprobes being developed for Sector 2. Prof. Jacobsen also presented a cryochamber design to be used to reduce radiation damage of biological samples and expressed his intention to contribute the chamber to the Sector.

Dr. E. Isaacs of AT&T Bell Laboratories presented inelastic x-ray scattering (IXS) results obtained at NSLS. He discussed data obtained on C<sub>60</sub>, and indicated that further measurements await beam time at the APS because a resolution near 0.1 eV is needed to make progress in the study of superconductivity in doped fullerenes.

Prof. R. Simmons from the University of Illinois at Urbana-Champaign was unable to attend, but sent three of his graduate students to represent him, R. Shah, D. Arms, and C. Venkataraman, who reported that a high-pressure (300 MPa) apparatus will be provided to SRI CAT for sample

environments for IXS experiments. The main interest of the UIUC group is in the solid heliums, which can be called quantum crystals.

Prof. R. Colella of Purdue University presented his plans for x-ray interferometry that exploits the long longitudinal coherence lengths of highly monochromatic beams by using multiple Bragg reflections for splitting and recombination.

On the topic of nuclear resonant scattering (NRS), Dr. J. Arthur from SSRL presented recent measurements of observation of <sup>83</sup>Kr and <sup>181</sup>Ta resonances. He also explained his interest in using x-ray NRS to study magnetism of thin films.

Prof. C. Kimball of Northern Illinois University proposed to study lattice dynamics of ferroelectric materials using inelastic NRS and explained his contribution of a cryostat with a superconducting 7T split-coil magnet to the beamline instrumentation.

Lastly, Prof. J. Mullen of Purdue University explained some interesting new results obtained in Debye-Waller factor measurements on MBE-grown thin films and explained how use of ultrahigh energy resolution via x-ray NRS can benefit such measurements.

All in all, the SRI CAT developers and scientific members' meeting was a success and ably served to bring many of the varied scientific interests and experimental plans of the CAT members together under one roof. The

re all feel pending the soon-to-be commissioned storage ring!

V. Yun, E. Alp, A. Macrander and I. McNulty ¶

## Calendar

Please remember to return your SRI CAT Proposal Forms to the Principal Investigator or Cheryl Zidel. We ask that you respond whether or not you are proposing a collaboration with a developer.

## Publications

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## People

We're sorry! We neglected to mention in the last issue that Dr. Joseph Zhongde Xu, previously a postdoctoral fellow with the APS Experimental Facilities Division, joined the scientific staff of Sector 2 in August of this year. Dr. Xu, educated at City University of New York and trained at the NSLS, brings expertise in high resolution spin-polarized photoelectron spectroscopy and beamline physics to the APS. Please welcome him to SRI-CAT.¶

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Address additions, changes and deletions are welcome. Forward them to the SRI CAT Secretary.

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